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Dioxin concentration in human milk in Hebei province in China and Tokyo, Japan: Potential dietary risk factors and determination of possible sources

Su-Ju Sun [a,b,d], Jian-Hong Zhao [a,c,d], Huai-Jun Liu [c], Dian-Wu Liu [b], Yu-Xia Ma [b], Li Li [e], Hyogo Horiguchi [a,c], Hideyuki Uno [a], Takao Iida [f], Minoru Koga [g], Yasuhiro Kiyonari [g], Masafumi Nakamura [h], Satoshi Sasaki [i], Hideo Fukatu [j], George C. Clark [k], Fujio Kayama [a,b,*]

[a] *Department of Environmental Medicine, Center for Community Medicine, Jichi Medical School, Tochigi 329-0498, Japan*
[b] *College of Public Health, Hebei Medical University, 050017 Shijiazhuang, China*
[c] *The Second Hospital, Hebei Medical University, 050000 Shijiazhuang, China*
[d] *CREST-JST, Kawaguchi, Saitama 332-0012, Japan*
[e] *Hospital of Gynaecology and Maternity of Shijiazhuang, Shijiazhuang 050017, China*
[f] *Fukuoka Institute of Health and Environmental Sciences, 39 Mukaizano, Dazaifu, Fukuoka 818-0135, Japan*
[g] *Faculty of Environmental and Symbiotic Sciences, Prefectural University of Kumamoto, Kummoro 862-8502, Japan*
[h] *Hiyoshi Corporation, Shinjuku, Tokyo 162-8636, Japan*
[i] *National Institute of Health and Nutrition, Ohmihachiman 523-8555, Japan*
[j] *SRL Inc., Tachikawa, Tokyo 190-8567, Japan*
[k] *Xenobiotic Detection System International Inc., Durham, NC 27704, USA*

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Abstract

Very limited information is available on body burdens and environmental levels of dioxins and dioxin-like PCBs (dl-PCBs) in mainland China. In the current studies, human milk samples were collected from 30 breastfeeding mothers in Shijiazhuang city (industrialized) and 11 in the Tanshan countryside (agricultural) of Hebei Province in northern China. An additional 20 samples were obtained from mothers in Tokyo, Japan. PCDDs, PCDFs, and dl-PCBs in human milk

Abbreviations: PCDDs, polychlorinated dibenzo-*p*-dioxins; PCDFs, polychlorinated dibenzofurans; PCDDs/Fs, PCDDs + PCDFs; PCBs, polychlorinated biphenyls; dl-PCBs, dioxin-like PCBs; TEQs, toxic equivalent quantities; HRGC-HRMS, high resolution gas chromatography/high resolution mass spectrometry; PCA, principal component analysis; PCP, pentachlorophenol; TCDD, tetrachlorodibenzo-*p*-dioxin; PeCDD, pentachlorodibenzo-*p*-dioxin; HxCDD, hexachlorodibenzo-*p*-dioxin; HpCDD, heptachlorodibenzo-*p*-dioxin; OCDD, octachlorodibenzo-*p*-dioxin; TCDF, tetrachlorodibenzofuran; PeCDF, pentachlorodibenzofuran; HxCDF, hexachlorodibenzofuran; HpCDF, heptachlorodibenzofuran; TCB, tetrachlorobiphenyl; PenCB, pentachlorobiphenyl; HxCB, hexachlorobiphenyl; HpCB, heptachlorobiphenyl.

* Corresponding author. Address: Department of Environmental Medicine, Center for Community Medicine, Jichi Medical School, Tochigi 329-0498, Japan. Tel.: +81 285 58 7336; fax: +81 285 44 8465.
E-mail address: kayamaf@jichi.ac.jp (F. Kayama).

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were analyzed by high-resolution gas chromatography/high-resolution mass spectrometry. Our results show that arithmetic means for body burdens of PCDDs/Fs and dl-PCBs in Hebei were 3.6 and 1.9 pg TEQ g^{-1} fat, respectively, which were only about one fourth of the levels in Japan. In addition, no difference was found in the chemical levels except dl-PCBs between the urban and rural areas. Based on the results of an in-person interview of the Chinese mothers using a 59-item questionnaire, freshwater fish consumption was found to correlate with the body burden of dioxins. Principal component analysis of dioxin congeners revealed that the patterns of dioxins in the Hebei urban and rural areas are quite similar; however, they are clearly different from those in Japan. Collectively, our results suggest that the lower body burdens of dioxin in Hebei may be due in part to the relatively slow industrialization and a lower consumption of marine foods. Finally, the results indicate that comprehensive monitoring of dioxins and dl-PCBs in humans as well as in the environment and foods is necessary in China.

Keywords: Dioxin; Dioxin-like PCB; Human milk; Hebei; Tokyo; Dietary factor; China

1. Introduction

Polychlorinated aromatic hydrocarbons, including PCDDs, PCDFs, and dioxin-like PCBs (dl-PCBs), are a class of widespread environmental contaminants. Due to their lipid solubility and low biodegradability, these ubiquitous pollutants may bioaccumulate in the human body as a result of concentration in the food chain. Dioxin exposure has been reported to suppress the immune system and thyroid, promote carcinogenesis, and cause birth defects, endometriosis, and altered sexual development (Fry, 1995; Kerkvliet et al., 1996; Dienhart et al., 2000; Hassoun et al., 2000; Steenland et al., 2004).

A great deal of data on environmental contamination by dioxins and dl-PCBs is available in the Western countries (Fürst et al., 1994; Schecter et al., 1994; Choi et al., 2002). Western countries had high levels of dioxins and dl-PCBs, which have decreased over the past two to three decades thanks to some effective countermeasures. China, however, may be facing environmental issues related to dioxins and dl-PCB due to rapid economic development and urbanization during the past twenty years. With the industrialization, municipal population growth, and life style change, these chemicals are of increasing concern in China. However, few investigations on the status and sources of pollution have been carried out in China, and very limited data are available on the environmental levels and body burdens of these chemicals (Schecter et al., 1996; Fu et al., 2003). In addition, the body burdens of dioxin and dl-PCBs in China may be affected by a variety of factors, including location, climate, ethnicity, and economic status.

Because dioxins and dl-PCBs are lipophilic compounds, they are concentrated through the food chain and are present in human milk. Thus, breast milk is widely used as a bioindicator for body burden of these chemicals due to the ease and non-invasive nature of collection (Fürst et al., 1994; Gladen et al., 1999). Furthermore, data on the levels of dioxins and PCBs in human breast milk are being accumulated throughout the world (Fürst et al., 1994; Schecter et al., 1994; Wolff and Toniolo, 1995; Choi et al., 2002).

In the current studies, we collected breast milk specimens from mothers in Shijiazhuang urban and Tangshan rural areas of Hebei Province in the northern of China. For comparison, we also collected 20 breast milk samples from mothers in Tokyo, Japan. These samples were analyzed for dioxins and PCBs by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS). At the same time, we carried out investigations on the dietary habits of the donors from Hebei Province to assess the dietary risk factors and to attempt to identify the sources of the chemicals.

2. Materials and methods

2.1. Samples

Breast milk samples were collected from 30 breast-feeding mothers in Shijiazhuang in 2002, 11 in Tangshan in 2003, and 20 in Tokyo in 2002. The former two regions are located in Hebei Province in northern China. Shijiazhuang is a large industrialized city with population of 2.9 million. In contrast, Tangshan is a traditional agricultural region. All of the specimens from Shijiazhuang and Tangshan were collected within 1 week postpartum. Thirty-seven subjects were primiparous and four were multiparous. In Tokyo, collection time ranged from 3 to 12 weeks postpartum. Twelve mothers were primiparous and eight were multiparous. Age of mothers in Hebei and Tokyo were within 22–35 (mean; 25.9) and 27–40 (31.7) years, respectively. Breast milk samples (50–70 ml) were frozen at −20 °C immediately after collection until analysis was performed. And all human milks in the studies were collected and analyzed after obtaining informed consent in accordance with Jichi Medical School guidelines.